Lab Validation Report

EMC Symmetrix VMAX Enginuity 5875

Virtualizing Tier-1 Applications with Confidence

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October 2011

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by EMC.

Introduction

This report presents an analysis of the value of the EMC Enginuity software update for the Symmetrix VMAX which was released for general availability in December, 2010. Analysis of the results of ESG Lab testing with VMware vSphere and Oracle RAC 11g was used to validate how VMAX software enhancements, including FAST VP and VMware VAAI API support, can be used to virtualize tier-1 applications with confidence.

Background

While a significant volume of market research has been published on the general use and benefits of server virtualization, much less information is available about the specific effects of this technology on various supporting infrastructure components such as servers, storage, and networking. In order to assess the current state of the server virtualization market, ESG recently surveyed 463 North America-based senior IT professionals representing large midmarket (500 to 999 employees) and enterprise-class (1,000 employees or more) organizations.[1] When viewed through an infrastructure lens, performance and management (e.g., visibility, sizing, and tools) account for the majority of the challenges identified by respondents, as shown in Figure 1.

Figure 1. Virtualization Challenges

Source: Enterprise Strategy Group, 2010.

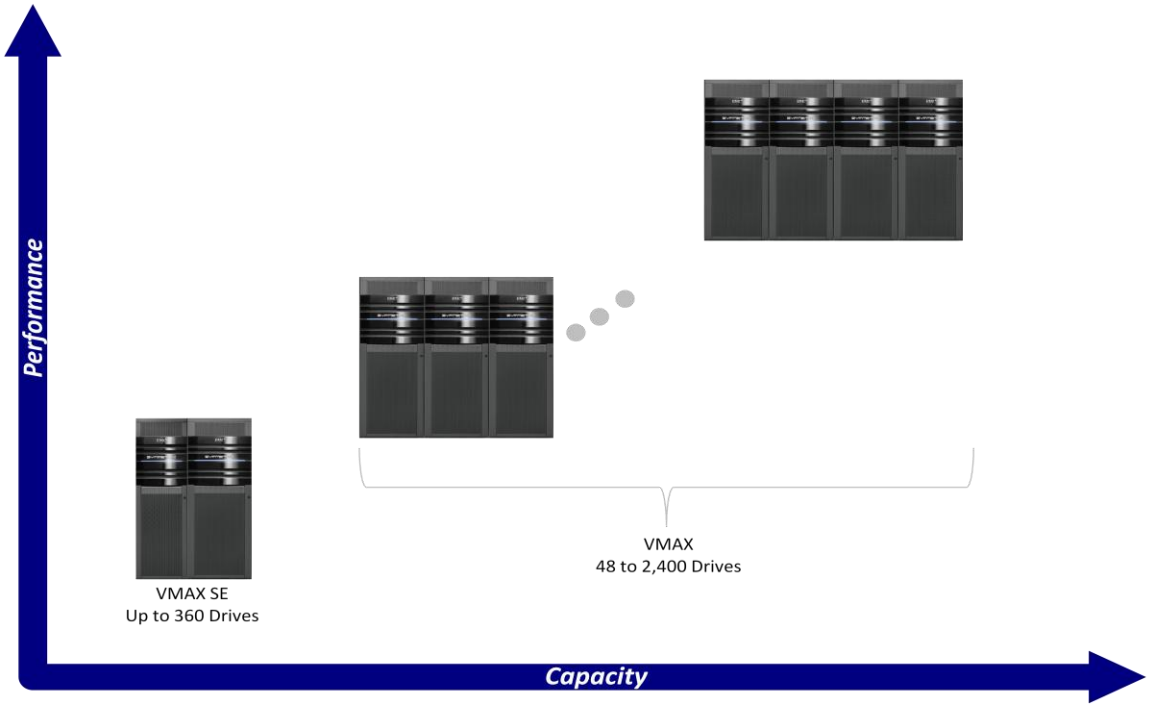
[1] Source: ESG Research Report, *The Evolution of Server Virtualization*, November 2010.

EMC's Symmetrix VMAX with Enginuity 5875 helps address these challenges by providing a flexible, easy to manage storage platform well suited for virtual environments. Automatic data movement, wizard-driven configurations, and VAAI API support all combine to enable virtualization of mission-critical applications.

Symmetrix VMAX Series Storage System

The EMC Symmetrix VMAX series system is a scale-out storage solution uniquely suited for large virtual environments, as shown in Figure 2. It is capable of scaling beyond a single frame to support up to two petabytes of storage capacity. The Symmetrix VMAX runs on the Enginuity operating code, enabling easy and flexible management from a single screen.

Figure 2. Symmetrix VMAX Series Hardware Platform



Symmetrix VMAX SE is an entry point VMAX solution into high-end storage. The VMAX SE arrays are configured around an integrated system bay that can be coupled with one storage bay to support up to 360 drives.

Symmetrix VMAX Engine consists of four quad-core 2.33 GHz Intel Xeon processors and up to 128 GB of memory. In its maximum configuration, the VMAX solution supports up to eight engines.

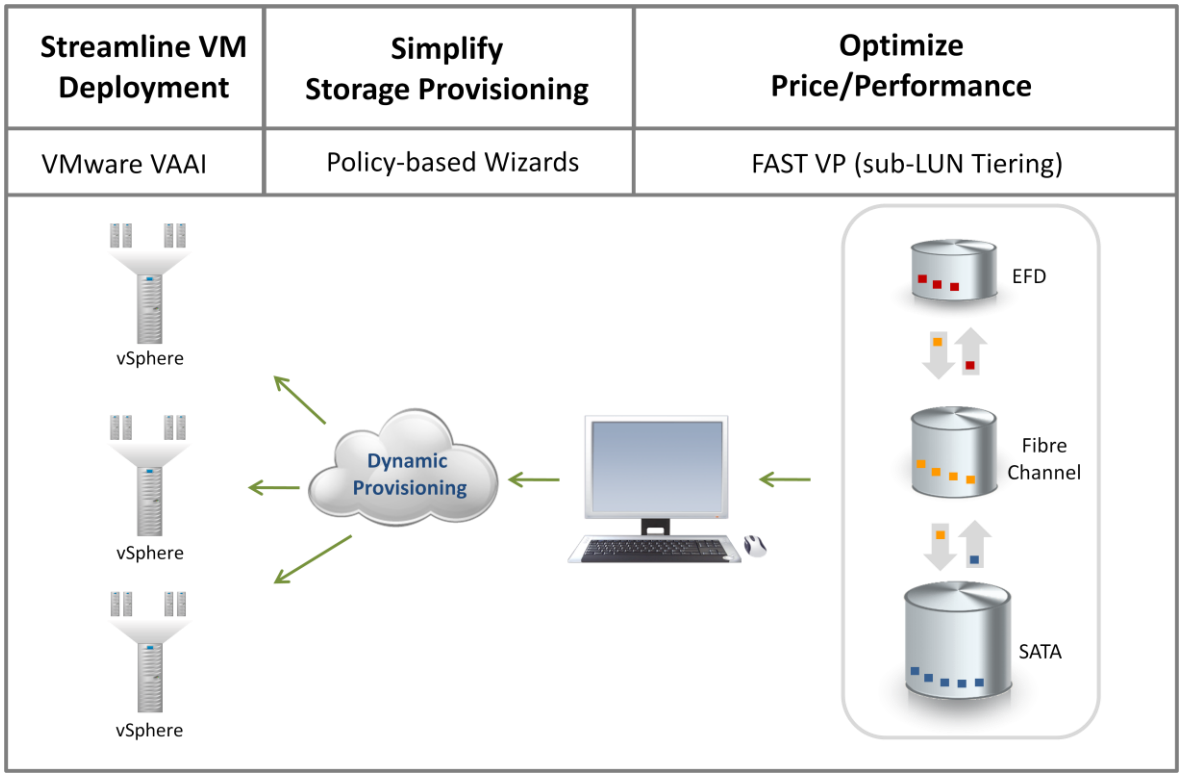
Symmetrix VMAX Connectivity supports both open system and mainframe environments. The Symmetrix VMAX can be configured with a maximum of 128 front-end ports supporting the following protocols: four and eight Gigabit FC, four and eight Gigabit FICON, and 1 and 10 Gigabit Ethernet for FCoE, iSCSI and SRDF.

Symmetrix VMAX provides support for Enterprise Flash Drives (EFD), Fibre Channel drives, and SATA drives. The Symmetrix VMAX solution scales from 48 to 2,400 drives for up to 2 PB of storage capacity.

Enginuity Version 5875

Enginuity version 5875 is the latest release of software running inside the field-proven EMC Symmetrix VMAX series of enterprise-class disk arrays. Enginuity version 5875 delivers more efficiency, more scale, and more security for large scale computing environments, as shown in Figure 3.

Figure 3. Enginuity 5875



Enginuity features:

VMware VAAI API Support to streamline virtual machine deployment and improve performance and efficiency in virtual server environments running vSphere version 4.1 or higher.

Faster Storage Provisioning with a growing family of policy-based wizards that provide an object-oriented view into ports, initiators, and storage groups.

Fully Automated Storage Tiering for Virtual Pools (FAST VP) using application policies and intelligent tiering algorithms to automatically move chunks of storage capacity to the right tier at the right time. FAST VP moves high performance data to enterprise flash drives (EFDs) to improve performance and less active data to high-capacity SATA drives to reduce costs.

Federated Live Migration to provide non-disruptive technology refreshes from DMX to VMAX disk arrays. This reduces the time needed for technology refresh from months to days as it increases efficiency with thick-to-thin migrations coupled with zero space reclaim.

Data at Rest Encryption to increase the security of sensitive applications using drive-level encryption. A unique encryption key for each drive is supported with RSA-integrated key management.

Native 10 GigE hot pluggable IO modules that provide high bandwidth Ethernet links for FCoE, iSCSI host connectivity, and Symmetrix Remote Data Facility (SRDF) replication.

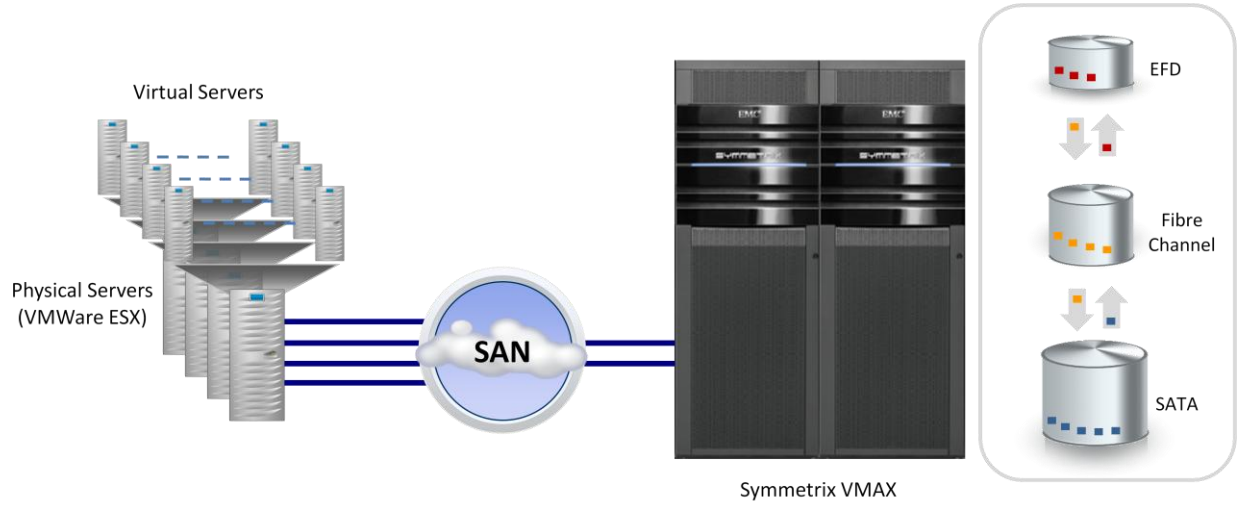
Why This Matters

A recent ESG survey indicates that "increased use of server virtualization" is the number one IT priority for the next 12-18 months.[2] Despite this desire, nagging issues and challenges exist. Scalability, performance, reliability, and security are key concerns that must be addressed before organizations can move from a strategy of lowering costs with the virtualization of IT productivity applications to improving quality of service for tier-1 business-critical applications. The latest release of Enginuity software was designed to help organizations virtualize tier-1 applications with confidence as it adds more efficiency, scale, and security to EMC's field-proven family of enterprise-class disk arrays.

ESG Lab Validation

ESG Lab performed hands-on evaluation and testing of Enginuity 5875 from an EMC facility in Hopkinton, MA, utilizing hardware and software physically located at another EMC facility located in Cork, Ireland, as shown in Figure 4. Testing was designed to demonstrate that Symmetrix VMAX with Enginuity 5875 can be used to virtualize tier-1 applications with predictable results.

Figure 4. Symmetrix VMAX with Enginuity 5875 Test Bed



ESG Lab testing also explored improved ease of use through new wizard-driven configuration utilities, VMware VAAI integration for quicker deployment, and Automated Data Movement via FAST VP.

[2] Source: ESG Research Report, *2011 IT Spending Intentions Survey*, January 2011.

EMC Symmetrix Management Console

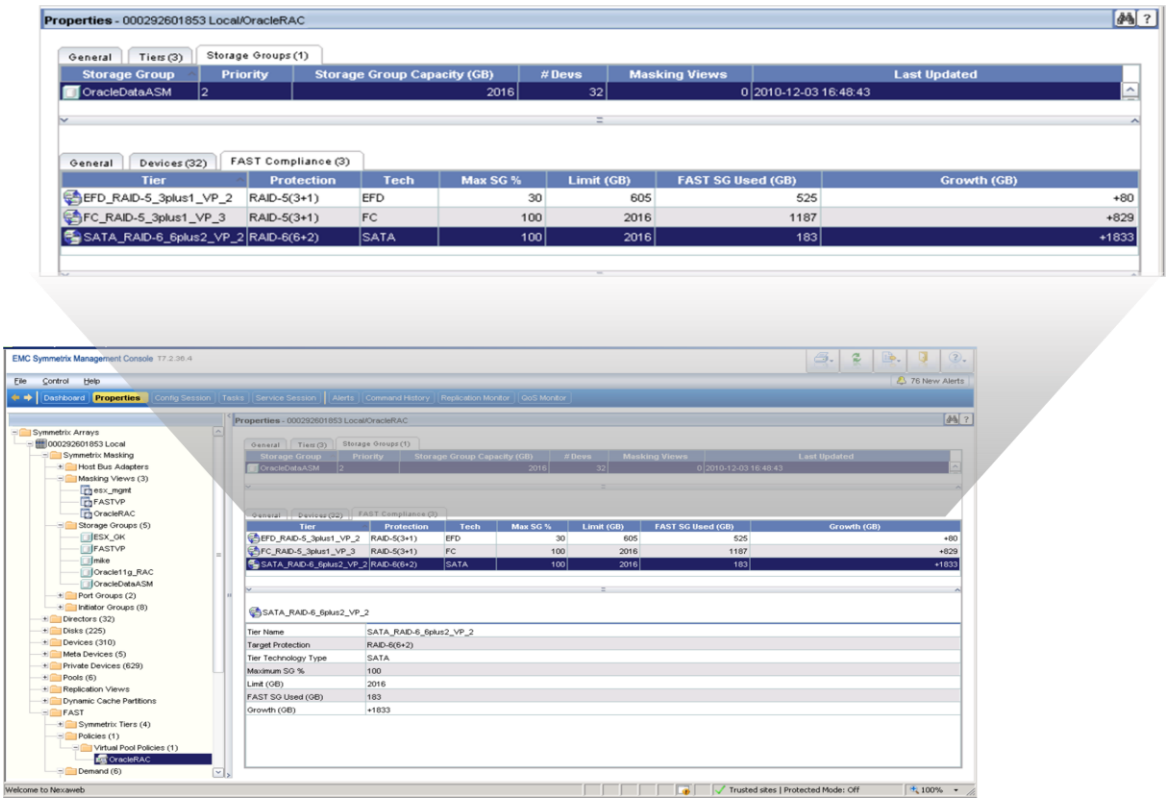
The EMC Symmetrix VMAX storage solution and Enginuity operating code features are managed with the Symmetrix Management Console (SMC). SMC is a comprehensive management tool that provides detailed visibility into the VMAX storage environment. A number of new wizard-driven utilities have been added to SMC to make management and configuration of the VMAX quicker and easier.

ESG Lab Testing

ESG Lab leveraged Symmetrix Management Console to test Enginuity 5875 features. SMC was used to review and validate test environment details as well as to confirm improved usability through the wizard driven configuration utilities.

ESG Lab confirmed that SMC provides a complete management interface capable of presenting detailed configuration information. Figure 5 shows the FAST policy configuration for virtual pool (Oracle RAC).

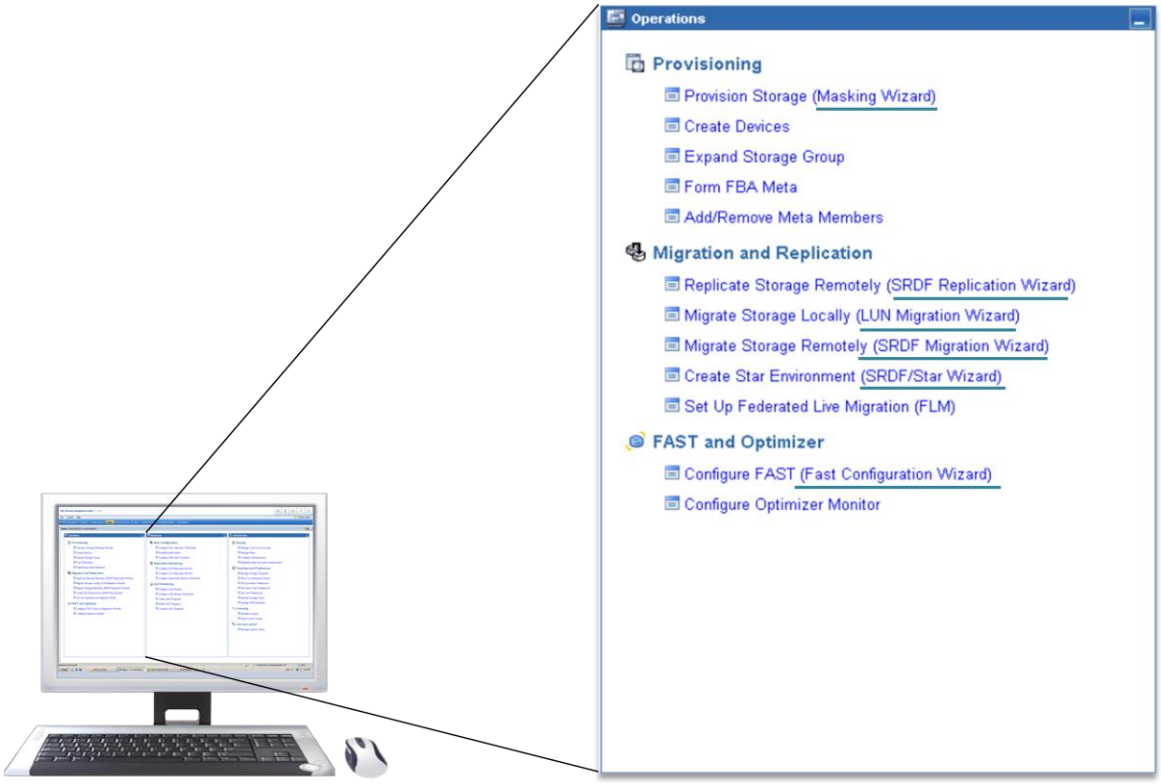
Figure 5. FAST Virtual Pool Policy



Detailed information for the supporting storage group (OracleDataASM) is also shown in Figure 5, including FAST storage group utilization rates, protection levels, and growth rates.

ESG Lab also confirmed improved ease of management via wizard-driven configuration tools. Figure 6 shows the operations section of the SMC tasks navigation pane. From the SMC tasks pane, the administrator can navigate through the operations, monitoring, and administration process for the Symmetrix VMAX storage solution.

Figure 6. SMC Wizard-driven Operations Tasks



Six of the eleven operations tasks now include wizard-driven configuration utilities. These wizard utilities help simplify the VMAX management from the basic storage provisioning tasks through SRDF replication setup and configuration. ESG Lab leveraged the FAST Configuration Wizard for the FAST VP (sub-LUN Tiering) section of this document.

FAST VP (Sub-LUN Tiering)

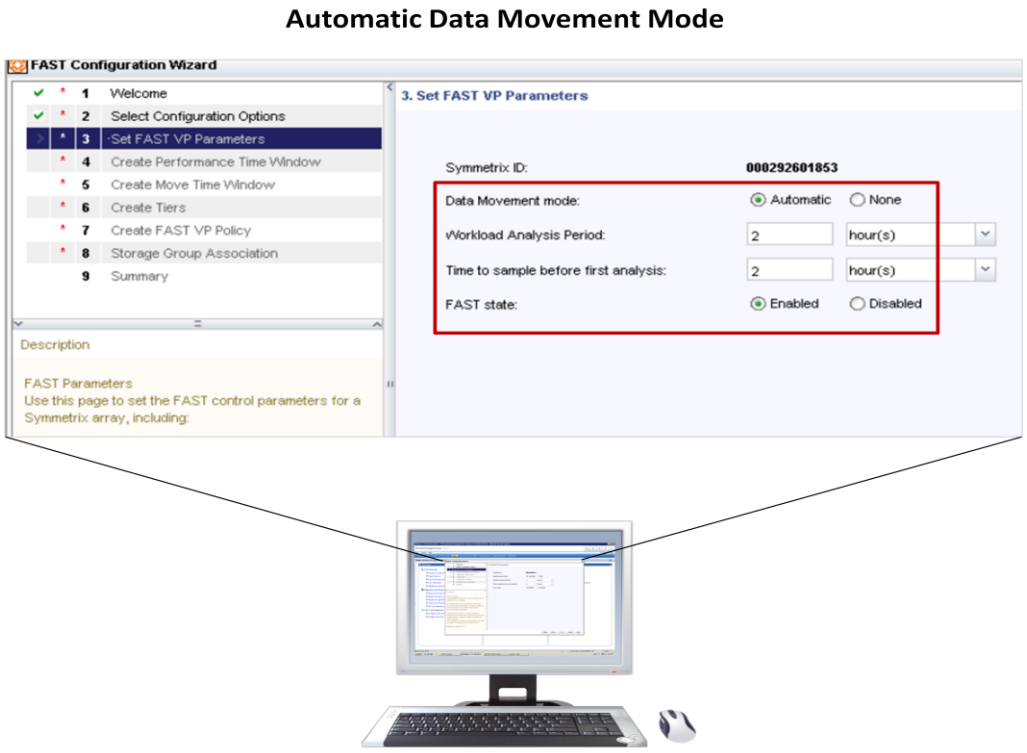
FAST VP uses application policies and intelligent tiering algorithms to automatically move chunks of storage capacity to the right tier at the right time. It can be used to optimize application performance with high-speed flash drives and reduce costs with high-density SATA drives.

ESG Lab Testing

ESG Lab tested FAST VP with a multi-user online transaction processing (OLTP) Oracle RAC 11g application running in a VMware-enabled virtual server environment. Database and storage performance statistics were captured before and after configuring FAST VP to move from a configuration with 128 15K RPM FC drives to a three-tier configuration that added eight 200 GB EFD drives and 28 high capacity SATA drives (2 TB). Symmetrix and Oracle statistics were monitored before and after the FAST VP policy had been running for 3.5 hours.

ESG Lab confirmed that wizard-driven FAST VP configuration is fast and intuitive, making it easy to walk through the process of configuring FAST VP. As shown in Figure 7, step three of the FAST Configuration Wizard is where automatic data movement is enabled. Enabling this feature allows FAST VP to automatically analyze, identify, and move data to the most efficient storage location based on access patterns.

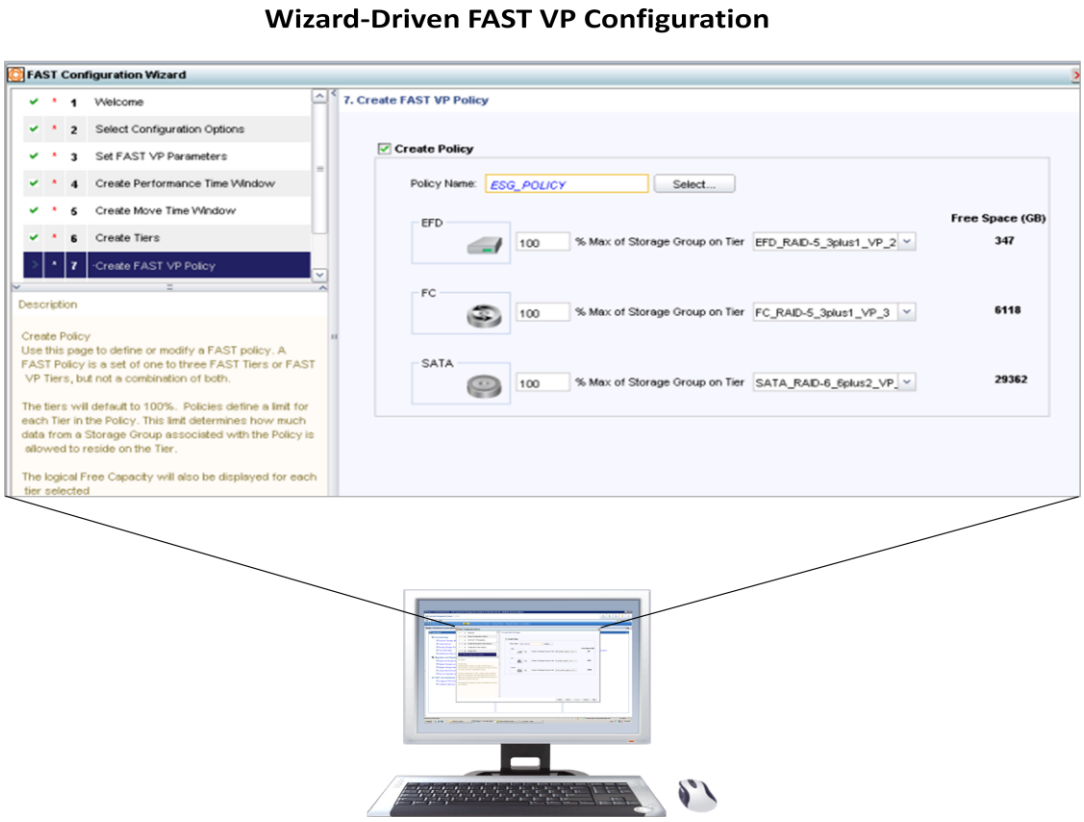
Figure 7. Automatic Data Movement Mode



Automatic Data Movement mode frees database and storage administrators from the repetitive tasks of performance analysis and tuning. FAST VP continuously tunes storage resources to ensure that the right data is placed on the right tier at the right time.

A policy of 100% was set for each tier for the Oracle Application as shown in Figure 8. This was chosen to let the FAST VP intelligent algorithms decide the tier capacities, optimizing both the performance and cost associated with the application. ESG Lab noted that values of less than 100% can be used to limit the amount of pool capacity used by each application.

Figure 8. FAST VP Policy Configuration



The swingbench load generator was used to emulate a 700-user online transaction processing (OLTP) system that generated more than 200,000 transactions per minute as it emulated a warehouse order entry application. FAST VP was configured with an aggressive relocation rate setting of one to observe maximum data migration during the testing window. EMC recommends using the default relocation rate of five or higher to minimize performance impact on application response times during FAST VP movements.

It should be noted that ESG Lab testing was performed with a goal of emulating a tier-1 database application that exceeds the performance requirements of most organizations. It should also be noted that the synthetic benchmark used during ESG Lab testing is more uniformly random than real-world applications that tend to have more locality of reference. As a result, ESG Lab is confident that most organizations will be able to use less EFD capacity to achieve similar, if not better, performance and cost benefits with FAST VP.

After three hours, 518 GB of the 2,016 GB of Oracle capacity had "tiered up" to EFD. The FAST performance algorithm identified 112 GB of inactive data which was migrated to SATA drives. As shown in Figure 9, FAST VP and EFD drives reduced Oracle IO response times by 50% for the virtualized Oracle application.

Figure 9. Oracle Performance with FAST VP

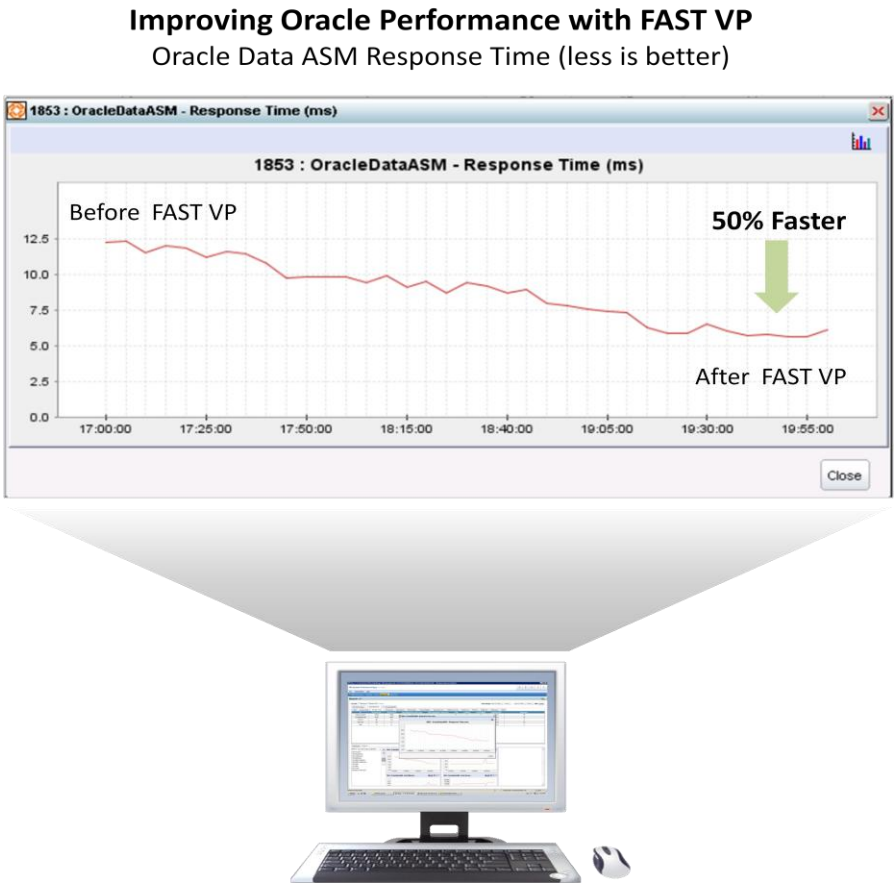
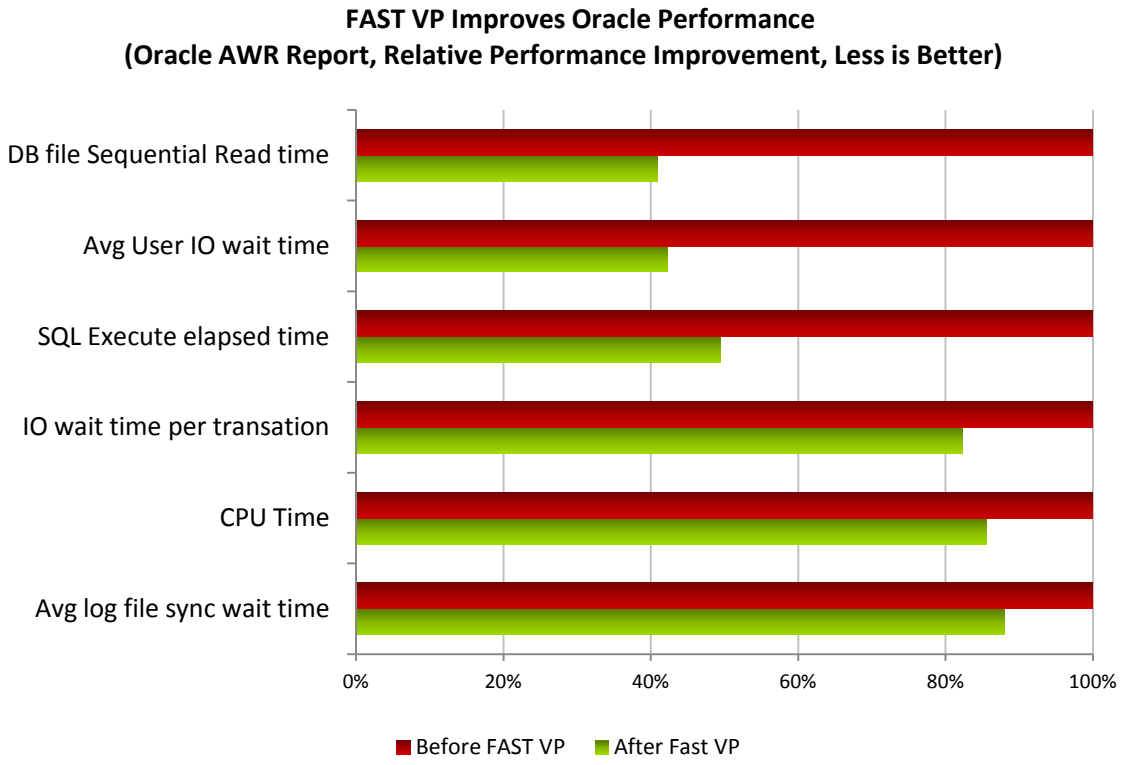


Figure 9 shows the Oracle response time via the EMC Symmetrix Performance Analyzer interface. The response times as well as host IO, host MB written, host throughput, and other stats can be viewed from the diagnostic tab pane within Symmetrix Performance Analyzer.

Oracle AWR reports also indicated that FAST VP improved performance for the top three time events (DB sequential read time, CPU time, and log file sync time, respectively) as shown in Figure 10. In other words, the top three events that the Oracle OLTP application was waiting for were improved with FAST VP.

Figure 10. Oracle AWR Report Detail



A closer review of Oracle AWR reports revealed the FAST VP delivered the results that can be seen in Table 1.

Table 1. Detailed Results for Oracle AWR

	Before FAST VP	After FAST VP	% Faster
DB File Sequential Read time (sec)	26393	10794	59%
Average User IO wait time (ms)	20.52	8.68	57%
SQL Execute elapsed time (sec)	33610	16631	51%
IO wait time per transaction (ms)	17	14	14%
CPU Time (sec)	1768	1512	12%
Average log file sync wait time (ms)	6.1	5.37	20%
Transactions per minute	939	1121	19%

What the Numbers Mean

- 59% faster DB sequential read times
- 57% less user IO wait time
- 51% less SQL execute elapsed time
- 14% less IO wait time
- 12% less CPU time
- 20% less log file sync wait time
- 19% more transactions per minute

Why This Matters

Companies continuously face challenges in cost-effectively meeting the capacity and performance requirements of applications, especially those with strict performance requirements. Failure to meet performance requirements can result in lost productivity and costly loss of services, but over-provisioning to avoid performance problems is a waste of money.

ESG Lab has confirmed that FAST VP can be used to improve the performance and cost-efficiency of tier-1 application delivery in a virtual server environment. During testing with a mix of EFD, FC, and SATA drives, FAST VP not only increased the performance of a fully virtualized Oracle RAC application, it also increased the amount of work that the virtualized infrastructure could handle.

With FAST VP, Symmetrix customers now have the option of moving from an all Fibre Channel drive configuration to a fully automated mix of SATA and EFD drives with movement of data happening automatically and transparently at the sub-LUN level. With guidance from the EMC pre-sales organization based on actual trace data analysis provided by the EMC Tier Advisor tool, ESG Lab is confident that most multi-user online applications can be moved to a mix of EFD and SATA that costs less, uses fewer drives, and consumes less power, cooling, and space.

VAAI Support

Enginuity version 5875 includes support for VMware vStorage APIs for Array Integration (VAAI). VAAI, which was introduced by VMware in vSphere version 4.1, offloads data-intensive operations to storage systems with a goal of accelerating the performance of common virtual server management operations. Three primitives are supported: Block Zeroing, which speeds the initialization of virtual machines; Full Copy, which accelerates the cloning and movement of virtual machines; and Scalable Lock Management, which streamlines coordination during virtual server management operations. By default, VAAI is turned on in a vSphere version 4.1 server. If the disk array is not VAAI capable, then the advanced primitives are simply not called.

ESG Lab Testing

Block Zeroing was tested with VMware version 4.1 and an EMC Symmetrix equipped with Enginuity version 5875 software. A two-node vSphere server cluster with a pair of Dell PowerEdge R710 servers, each with 32 GB of RAM, was used during this phase of testing. The time that it took to initialize a 40 GB virtual machine was measured before and after VAAI Block Zero API acceleration. As shown in Figure 11, the 40 GB virtual machine initialized 8.6 times faster with VAAI. ESG Lab audited the results of EMC tests for larger virtual machines and confirmed that the performance benefit is magnified as the size of the virtual machine increases—a 200 GB virtual machine initialized *17.87 times faster* on a Symmetrix VMAX equipped with Enginuity version 5875 and VAAI Block Zero support.

Block Copy was tested with a 20 GB virtual machine that was 80% full, containing Windows Server 2008 R2 operating system and application data, as shown in Figure 12. The time that it took to clone a VM before and after VAAI Block Copy acceleration was measured: cloning time was reduced from minutes to seconds as the 20 GB virtual machine was cloned 2.7 times faster with VAAI and the EMC Symmetrix VMAX.

Figure 11. VAAI Block Zero API Acceleration

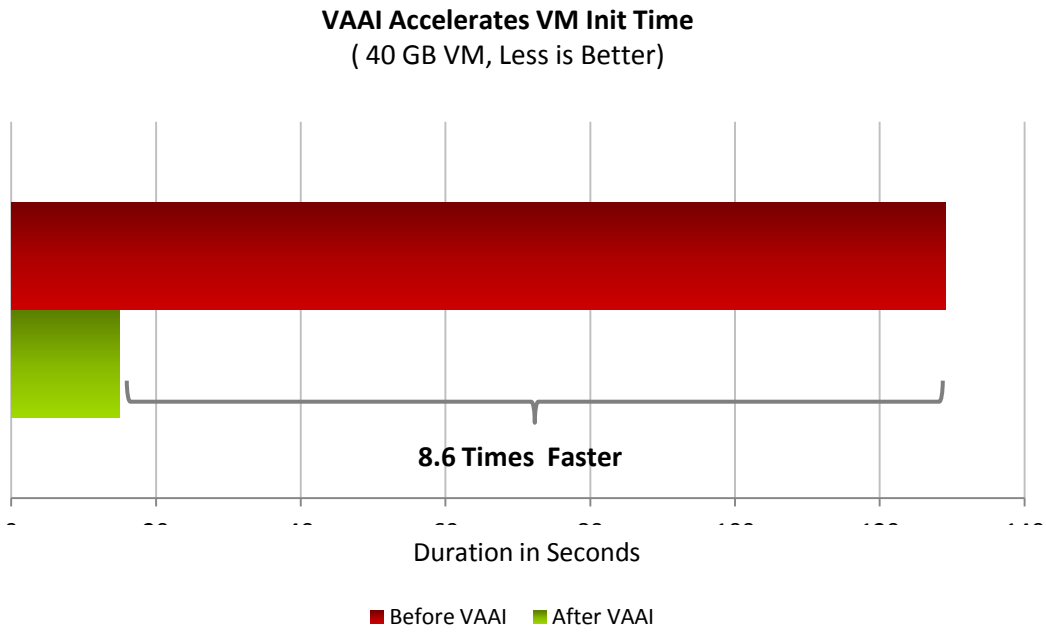


Figure 12. VAAI Full Copy Acceleration

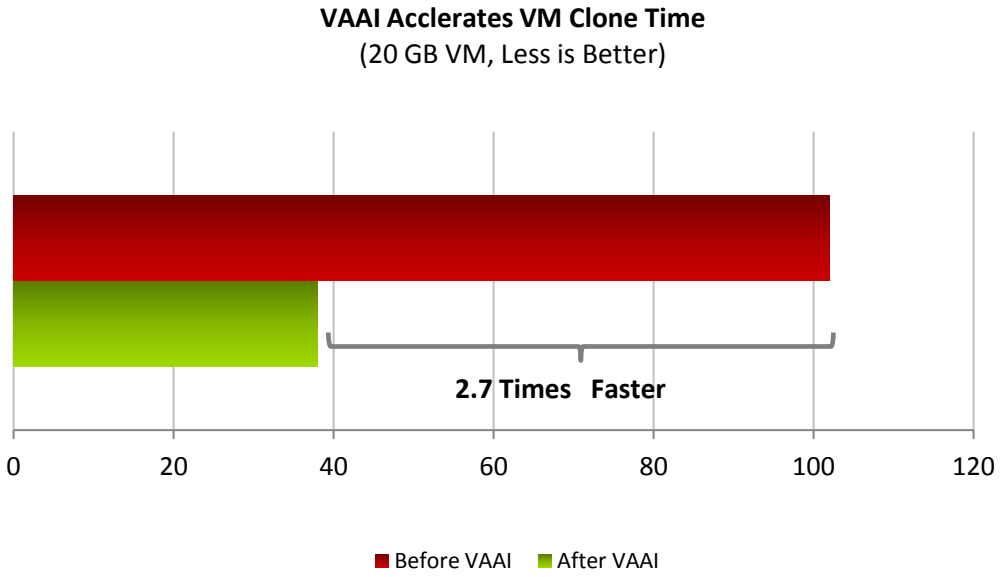


Table 2. Detailed Results for Figures 11 and 12

	Before VAAI	After VAAI	% Faster
VM Init Time (sec)	129	15	88%
VM Clone Time (sec)	102	38	63%

What the Numbers Mean

- VAAI integration improves the VM init process by 88%
- VAAI integration improves the VM clone process by 63%

Why This Matters

VAAI frees up hypervisor compute power, which can be used to run more virtual machines. This can increase VM to host ratios without adding more physical server resources or it can increase the workload each VM can handle.

VAAI reduces the time needed for virtual server administration (faster VMotion, Storage VMotion, cloning, VM deployment, and more) to help the IT organization respond faster to the needs of the business as it reduces the time and expense associated with virtual server administration.

VAAI Block Zeroing makes it easier to take advantage of VMware fault tolerance. VMware fault-tolerance-enabled VMs need their virtual disks converted from either the thin disk or zeroed thick disk format to the eager zeroed thick disk format. This process can be very time-consuming as the conversion process zeros every block on the virtual disk. VAAI Block Zeroing drastically reduces the time—and overhead—of this operation as it uses far fewer IO commands to get the job done.

ESG Lab Validation Highlights

- ☑ ESG Lab confirmed that EMC is continuously improving the wizard-driven storage provisioning process for its Symmetrix product line.
- ☑ In a previous Lab report, ESG confirmed that VMAX virtual provisioning was 82% faster and significantly easier (83% fewer operations, less decisions, and significantly more automated) than traditional provisioning methods.
- ☑ A tier-1 Oracle RAC application was virtualized on an EMC Symmetrix with VMware vSphere 4.1.
- ☑ VP and EFD drives dramatically increased the scalability and performance of a tier-1 OLTP application supporting 700 simulated users and more than 200,000 transactions per second. Oracle AWR reports indicate that 19% more transactions were processed as response times were reduced by 50% and user wait times were reduced by 58%.
- ☑ A 40 GB virtual machine was configured 8.6 times faster and a 20 GB virtual machine was cloned 2.7 times faster with the VAAI support built into VMware vSphere 4.1 and EMC Symmetrix disk arrays running Enginuity version 5875 software.

Issues to Consider

- ☑ Deploying FAST VP with real-world applications should magnify the performance gains achieved during ESG Lab testing because the synthetic benchmark used is more uniformly random than real-world applications. As a matter of fact, an ESG Lab audit of trace data collected from EMC customers has confirmed that most organizations will see more performance gains with real-world applications using significantly less flash drive capacity.
- ☑ Similarly, deploying FAST VP with high density SATA drives and mature real-world applications should get better savings than were achieved during ESG Lab testing. Applications that have been running in production for months or years should have larger amounts of inactive data and would benefit from additional cost savings as more data is moved to cost-effective SATA drives.
- ☑ Using EMC's Tier Advisor tool, the EMC pre-sales organization can help quantify the benefit of FAST VP for an existing environment based on analysis of actual trace data.

The Bigger Truth

Moving to the next level of virtualization is a struggle for many organizations. Most have already picked the low hanging fruit, moving utility, test, and development servers/services from physical to virtual and reaping the benefits of this shared resource consolidation. Moving tier-1 applications can prove to be a much bigger challenge. Optimal performance and manageability were not often a concern in early virtual environments. The following architectural components must be considered with mission-critical application virtualization:

- Predictable performance results
- Quick and easy storage and server provisioning
- OPEX cost of supporting non-automated environments
- Infrastructure visibility
- Mature management tools

EMC Symmetrix has a solid history of supporting mission-critical applications in tier-1 environments. The Enginuity 5875 software update, released for general availability in December 2010, extends the enterprise-class capabilities of this field-proven product line.

ESG Lab has verified that the increased scalability and efficiency of EMC Symmetrix can be used to virtualize an Oracle RAC application with VMware vSphere. Application-level performance for an Oracle OLTP application was dramatically improved using a combination of FAST VP technology and high-speed enterprise flash drives. Improved wizard-driven storage provisioning tasks made configuration quick and easy. VAAI-enabled offload increased efficiency as it dramatically accelerated the time it takes to deploy and manage a virtual server environment. Put it all together and it's clear that Enginuity version 5875—with more efficiency, more scale, and more security—can be used to virtualize tier-1 applications with confidence.

Appendix

Table 3. ESG Lab Test Bed Details

Hardware Configuration	
1 Symmetrix VMAX Storage Solution	2 x VMAX 64 GB engines 8 Gb FC connectivity 128 x 300 GB, 15k FC drives 28 x 2 TB 7,200 rpm SATA drives 8 x 200 GB EFD drives
2 VMware ESX Servers	4 x eight-core CPUs 128 GB RAM 2 x quad-port 1 Gb NICs
2 Oracle RAC database servers	4 x eight-core CPUs 128 GB RAM 2 x quad-port 1 Gb NICs
2 Ethernet Switches	Gigabit Ethernet switches
2 FC SAN Switches	Brocade 5100 switches, 40 ports per switch
8 FC Host Bus Adapters	8 Gb quad-port HBAs (2 per physical server)
Physical Resource Allocation for Virtual Machines	
8 Oracle RAC nodes	6 vCPUs 20 GB RAM RHEL 5.5
1 VMware vCenter Server*	2 vCPUs 8 GB RAM Windows 2008 Server SP2
EMC SMC/SPA Server*	2 vCPUs 4 GB RAM Windows 2008 SP2
Swingbench Server*	4 vCPUs 8 GB RAM Windows 2008 Server SP2
Software Configuration	
EMC Symmetrix VMAX Enginuity	Version 5875 VMAX code
EMC PowerPath/VE	Version 5.4.2 Multipath
EMC Solutions Enabler	Version 7.2 VMAX management software
EMC Symmetrix Performance Analyzer	Version 2.0.1.4 VMAX performance analysis tool
EMC Symmetrix Management Console	Version 7.2 VMAX configuration and management tool
EMC Virtual Storage Integrator	Version 4.0 EMC storage plug-in for vCenter
VMware vSphere	Version 4.1 Hypervisor for all virtual machines
VMware vCenter	Version 4.1 vSphere management software
Oracle Database 11g (with Oracle RAC and Oracle Grid)	Enterprise Edition 11.2.0.2 Oracle cluster for grid

Note: * These virtual machines reside on an existing ESX Server used only for management purposes.

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